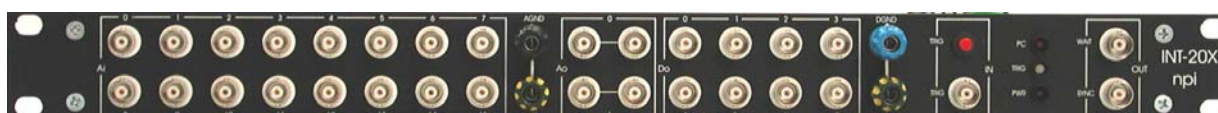# OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

INT-20X

BREAKOUT BOX
FOR RECORDING AND GENERATING ELECTRICAL SIGNALS

VERSION 3.6
npi 2014

_____

Table of Contents

_____

_____

1. Safety Regulations

VERY IMPORTANT: **Instruments and components supplied by npi electronic are NOT intended for clinical use or medical purposes (e.g. for diagnosis or treatment of humans), or for any other life-supporting system. npi electronic disclaims any warranties for such purpose. Equipment supplied by npi electronic must be operated only by selected, trained and adequately instructed personnel. For details please consult the GENERAL TERMS OF DELIVERY AND CONDITIONS OF BUSINESS of npi electronic, D-71732 Tamm, Germany.**

1) GENERAL: This system is designed for use in scientific laboratories and must be operated only by trained staff. General safety regulations for operating electrical devices should be followed.

2) AC MAINS CONNECTION: While working with the npi systems, always adhere to the appropriate safety measures for handling electronic devices. Before using any device please read manuals and instructions carefully.
   The device is to be operated only at 115/230 Volt 60/50 Hz AC. Please check for appropriate line voltage before connecting any system to mains.
   Always use a three-wire line cord and a mains power-plug with a protection contact connected to ground (protective earth).
   Before opening the cabinet, unplug the instrument.
   Unplug the instrument when replacing the fuse or changing line voltage. Replace fuse only with an appropriate specified type.

3) STATIC ELECTRICITY: Electronic equipment is sensitive to static discharges. Some devices such as sensor inputs are equipped with very sensitive FET amplifiers, which can be damaged by electrostatic charge and must therefore be handled with care. Electrostatic discharge can be avoided by touching a grounded metal surface when changing or adjusting sensors. **Always turn power off when adding or removing modules, connecting or disconnecting sensors, headstages or other components from the instrument or 19" cabinet.**

4) TEMPERATURE DRIFT / WARM-UP TIME: All analog electronic systems are sensitive to temperature changes. Therefore, all electronic instruments containing analog circuits should be used only in a warmed-up condition (i.e. after internal temperature has reached steady-state values). In most cases a warm-up period of 20-30 minutes is sufficient.

5) HANDLING: Please protect the device from moisture, heat, radiation and corrosive chemicals.

6) I/O BOARDS: This breakout box can be used only with computer boards from National Instruments. These I/O boards must be installed and configured first. For the correct installation and configuration read the user manual of the appropriate board (shipped with the board).

7) VERY IMPORTANT**:** Always turn power off when connecting or disconnecting components at the rear panel of the breakout box to avoid any damage.

_____

_____

2. INT-20X Breakout Box

2.1. *System Description*

The INT-20X is a universal breakout box providing access to the PCI B series and PCI M series multifunction I/O boards from National Instruments with a 68 pole SCSI connector (male) like:

❏ PCI-6221 (low cost 16-bit M series board)
❏ PCI-6014 (low cost 16-bit B series board, Windows only)

The standard system consists of the INT-20X breakout box, B, M or E series board and software to record up to 16 analog signals and store the data on hard disk. 2 analog output channels to generate analog signals and a digital port with 8 digital lines to write digital signals (TTL) are available as well. Usually this breakout box is used with the software package CellWorks E, but it is also possible to write own programs for example with the program development application *LabVIEW* from National Instruments. CellWorks is a modular program especially developed for electrophysiological and pharmacological experiments. It is used to automate experimental protocols under computer control. Contact npi for more information on CellWorks.
The free WinWCP and Win EDR software from the University of Strathclyde works also well with these NI boards and the INT-20X.
A digital POWER OUTPUT port with 8 lines, e.g. to control the magnetic valves of perfusion systems, is also available.

The INT-20X also provides a TRIG IN connector for triggering CellWorks from an external device and two TRIG OUT signals (WAIT and SYNC). WAIT indicates that the software is waiting for a trigger (only in PULSE mode) and SYNC can be used to synchronize external devices with the data acquisition rate.

Note: The INT-20X breakout box does not include the I/O connector for the PCI-6503 board. If you intend to use more than 8 digital lines, e.g. for controlling valves and a npi amplifier contact npi for detailed information on additional hardware.

Important: You must install and configure the computer board(s) first before you connect the other hardware components. Please read the NI user manual of the appropriate board for instructions on installing and configuring the boards.

_____

_____

2.2.   Parts Shipped with the Breakout Box

❏ Breakout box INT-20X
❏ Breakout box User Manual

Optional accessories:
❏ 68 pole SCSI cable
❏ External power supply
❏ 4 or 8 Channel Bath Perfusion System (ALA)
❏ Filter modules (to avoid aliasing or to reduce noise)
❏ Amplifiers
❏ CellWorks E
❏ Hard- and Software from National Instruments:

_____

_____

2.3. Description of the Front Panel

Figure 1 shows the INT-20X front panel. Table 1 includes a short description of all front panel elements. The names in brackets are the signal denotations used in the PCI M-Series User Manuals from National Instruments.
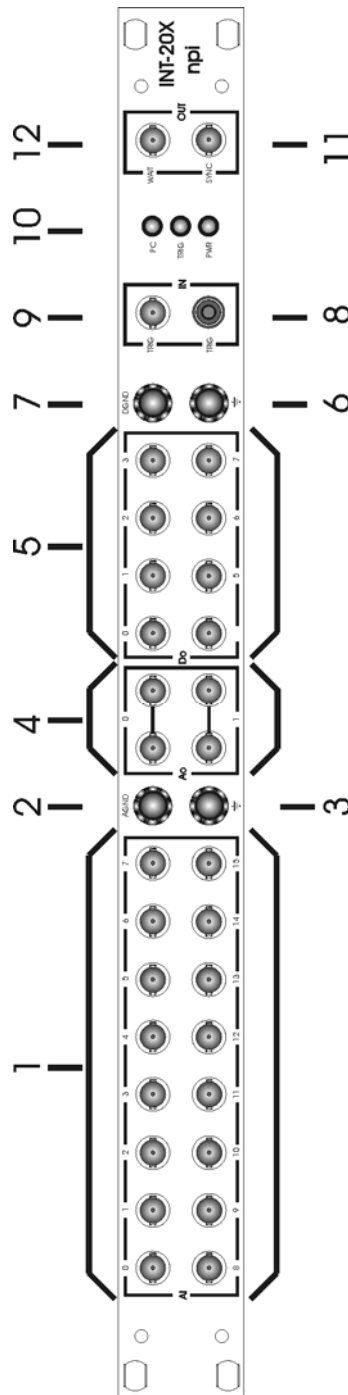
Figure 1: front panel of the INT-20X breakout box

_____

Front panel			
Number	**Short name**	**Signal name**	**Description**
1	Ai0...Ai15 (ACH0...ACH15)	Analog input channels (Analog Input)	16 BNC connectors providing the 16 analog input channels of the B, M or E series board.
2	AGND (AISENSE)	Analog input ground (Analog Input Sense)	This connector supplies the reference point for all analog input channels.
3	GND	Ground	Chassis potential.
4	Ao0...Ao1 (DAC0...DAC1)	Analog output channels (Analog Outputs)	These BNC connectors provide the 2 analog output channels of the B, M or E series board.
5	Do0...Do7	Digital output ports (Digital I/O)	These output ports provide the 8 digital lines from the E-Series board.
6	GND	Ground	Compare to number 3.
7	DGND (DGND)	Digital ground (Digital Ground)	This connector supplies the reference point for all digital signals.
8	TRIG	Manual trigger	This push button triggers the B, M or E series board manually
9	TRIG (TRIG1)	Trigger input	This BNC connector provides the timing signal PFI1/TRIG1 from the E-Series board for connecting an external trigger device with active low logic.
10	PC, TRIG, PWR	PC connection, Trigger, Power supply connection	LED PC indicates the connection between the computer and the breakout box (computer must be switched on). LED TRIG indicates the Trigger status (green = trigger active, red = waiting for trigger). LED PWR indicates that an external power supply is plugged in.
11	WAIT (GPCTR1_OUT)	"Wait for Trigger" signal (only in PULSE mode)	LOW (0 V) by default. Gets HIGH (+5 V) if CellWorks waits for a trigger and remains high until STARTSCAN has been started (see Figure 2). _Note_: GPCTR1_OUT is set by software and therefore not very precise (a few ms).

12	SYNC (STARTSCAN)	Synchronization signal	LOW (0 V) by default. Gets HIGH (+5 V) for ~500 ns before each scan, i.e. during data acquisition this signal has the same frequency as the sample rate set in CellWorks (see Figure 2). *Note*: STARTSCAN is set by hardware and therefore precise.

Table 1: front panel elements of the INT-20X breakout box

The signals at the front panel can be divided into 5 groups: **Ai, Ao, Do, TRIG IN, TRIG OUT**. Each group is indicated at the front panel by a surrounding white line.

Analog input (Ai0...Ai15)

The 16 analog input lines from the PCI M-Series board are linked to BNC connectors at the front panel. These channels have a maximum voltage range of ±10 V and cab be configured by software. The maximum sample rate and the resolution is dependent on the PCI board that is installed. A resolution of up to 16 bit and sample rate up to 1.25 MS/s (**M**ega **S**amples per **s**econd) is possible. We recommend to use sampling rates of 10-20 times the maximum measured frequency (to avoid aliasing the sampling frequency must be ≥ 2 x f_{max},).
The shields of all Ai BNC connectors are linked to the AISENSE signal and the AISENSE is connected to the AIGRND signal from the PCI Series board. The INT-20X supports two modes of data acquisition: NRSE (**N**on **R**eferenced **S**ingle **E**nded) and DIFF (Differential). For further information please read the PCI Series user manual. Usually, NRSE is used.

Analog output (Ao0...Ao1)

The two analog outputs from the PCI board are available at the front panel. Each channel has two BNC connectors. With these ports it is possible to generate analog voltage signals in a range of ±10V. The resolution and the maximum update rate is dependent on the PCI board. For further information please read the technical data of the PCI board that is connected.

Digital output (Do0...Do7)

The 8 digital I/O (**I**nput/**O**utput) lines of the PCI board are linked to the front panel. The signals are **fixed in output direction** and buffered. Driving several TTL inputs of external devices is possible.

_____

Control inputs and control outputs (TRIG IN, TRIG OUT)

The PCI board provides a lot of timing signals and PFI signals (**P**rogrammable **F**unction **I**nput) to control the PCI board by external devices or vice versa. 2 input signals and 2 output signals are linked to BNC connectors at the front panel. The following table shows the default configuration.

Note: The GPCTR1_OUT signal is linked to the BNC WAIT connector only in PULSE mode operation of CellWorks and therefore, the trigger status LED is in CHART mode operation always green.

Signal from PCI board to	Front panel BNC
PFI0/TRIG1	Input BNC TRIG
PFI0/TRIG1	Input push button TRIG
GPCTR1_OUT (only in PULSE mode)	Processed and linked to output BNC WAIT
STARTSCAN	Output BNC SYNC

Front panel LEDs (PC, TRIG, PWR)

There are three LEDs PC, TRIG and PWR which are used to indicate proper connections to the computer or to external devices and the trigger status. If the LED PC is on (red) the PCI E-Series Board in the computer is connected properly to the breakout box (the computer must be switched on). The LED in the middle, TRIG, indicates the trigger status (green = trigger active, red = waiting for trigger, also indicated in CellWorks by the red field in the Execution Module). If the LED PWR is red an external power supply is properly connected.
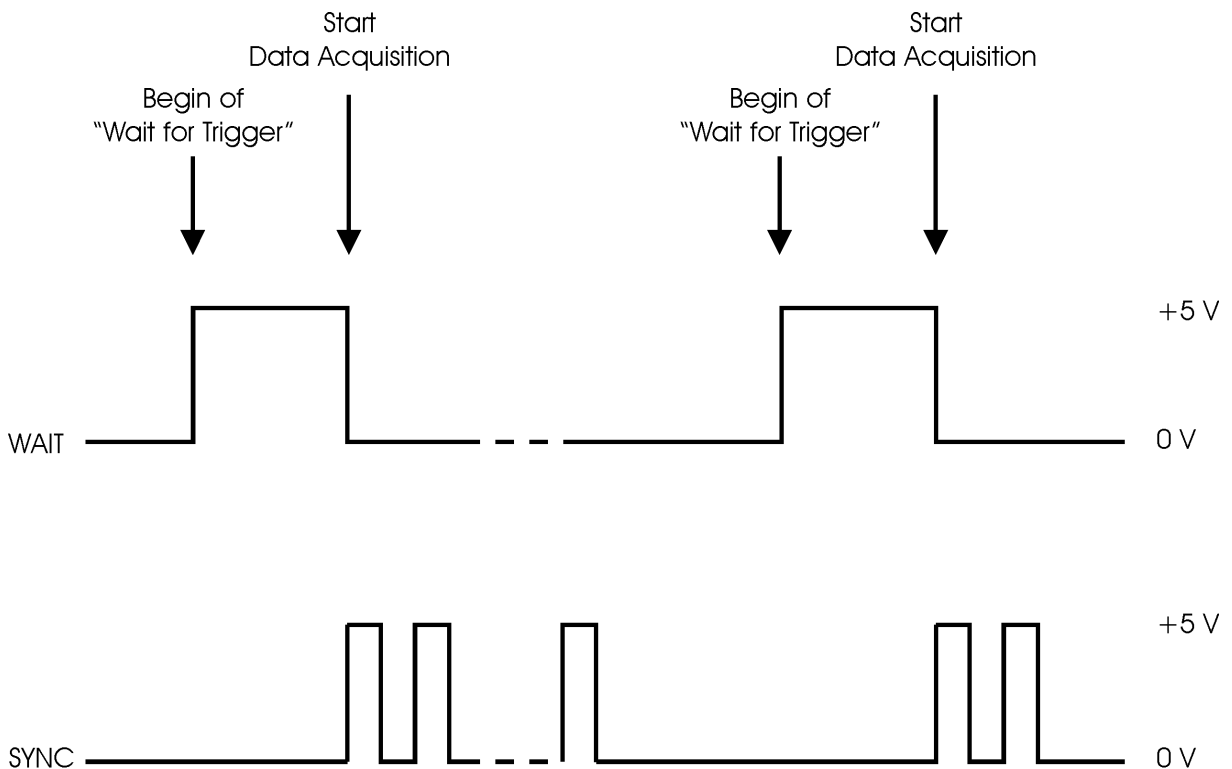

Figure 2: time course of trigger out signals

_____

_____

2.4. Description of the Rear Panel

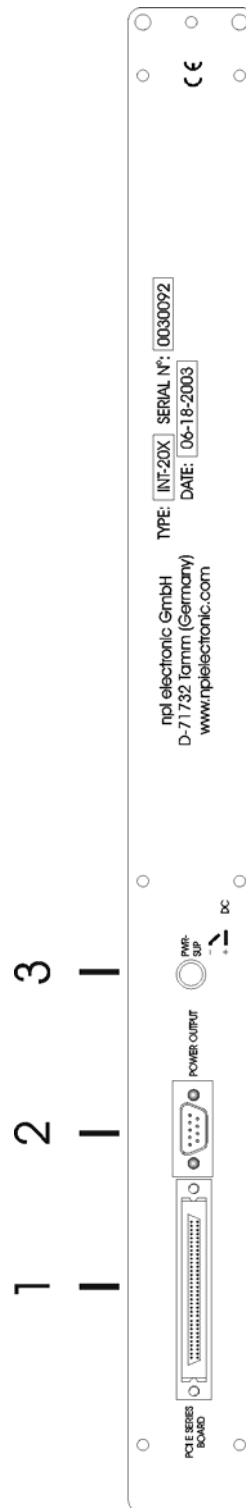Figure 3 shows the INT-20X rear panel Table 2 gives a short description of the INT-20X rear panel elements.

Figure 3: rear panel of the INT-20X breakout box

_____

Rear panel		
Number	**Name**	**Description**
1	B or E SERIES BOARD	SCSI 68 pole male connector to connect the B, M or E series board.
2	POWER OUPUT	SUBD 9 female connector to control directly valves of a perfusion system etc.
3	PWR-SUP	Connector for the external power supply.

Table 2: rear panel elements of the INT-20X breakout box

Three elements located at the rear panel of the INT-20X are necessary to interface the breakout box to the PCI board, to external devices, e.g. to a perfusion system and to connect an external power supply to the INT-20X.

PWR-SUP

The external power supply must be connected to the round connector PWR-SUP. Power supplies up to a maximum voltage of 36V can be plugged in.

Important: Attention to the right polarity: The core pine is positive and the coat is negative.

POWER OUTPUT

Some applications need more power (more current and higher voltage) than a ordinary TTL-output can supply. The SUBD 9 female connector POWER OUTPUT supplies 8 digital power output channels. The voltage value depends on the external power supply you have plugged in (usually 12 V). Thus, direct valve switching is possible. The digital port A+B of the PCI board is linked and powered up to this output. The pinout of this connector is shown in Table 3 and Table 4.
Pins 1 to 8 are linked directly to the SUBD 9 female connector of the BPS system and are going to the respective valves. Pin 9 is linked to Pin 9 of the SUBD 9 female connector of the BPS system and provides power (usually 12V). All are switched open collector.

Note: This power port is configured in active low logic. A step from low to high (from 0V to 5 Volt) causes a step from $V_{power\ supply}$ to 0V.

_____

Pin	Name
1	POWC0
2	POWC1
3	POWC2
4	POWC3
5	POWC4
6	POWC5
7	POWC6
8	POWC7
9	+V

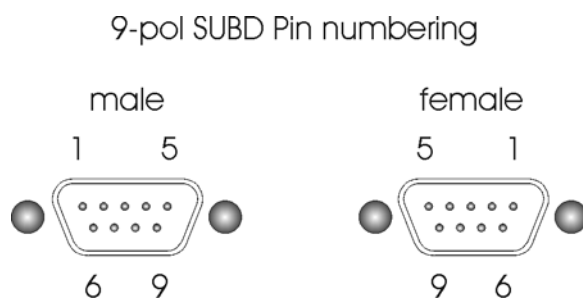Table 3: pinout of the SUBD 9 female connector POWER OUTPUT

Table 4: numbering of SUBD 9 connectors

_____

_____

PCI B or M SERIES BOARD (not PCI-6071E)

The PCI board is connected to the SCSI 68 pole male connector PCI M SERIES BOARD. A 68 pole SCSI pin to pin cable is required.

Pin	Name	Pin	Name
1	FFREQ_OUT	35	DGND
2	GPCTR0_OUT	36	DGND
3	PFI9/GPCTR0_GATE	37	PFI8/GPCTR0_SOURCE
4	DGND	38	PFI7/STARTSCAN
5	PFI6/WFTRIG	39	DGND
6	PFI5/UPDATE	40	GPCTR1_OUT
7	DGND	41	PFI4/GPCTR1_GATE
8	"+5V"	42	PFI3/GPCTR1_SOURCE
9	DGND	43	PFI2/CONVERT
10	PFI1/TRIG2	44	DGND
11	PFI0/TRIG1	45	EXTSTROBE
12	DGND	46	SCANCLK
13	DGND	47	DIO3
14	"+5V"	48	DIO7
15	DGND	49	DIO2
16	DIO6	50	DGND
17	DIO1	51	DIO5
18	DGND	52	DIO0
19	DIO4	53	DGND
20	EXTREF	54	AOGND
21	DAC1OUT	55	AOGND
22	DAC0OUT	56	AIGND
23	ACH15	57	ACH7
24	AIGND	58	ACH14
25	ACH6	59	AIGND
26	ACH13	60	ACH%
27	AIGND	61	ACH12
28	ACH4	62	AISENSE
29	AIGND	63	ACH11
30	ACH3	64	AIGND
31	ACH10	65	AIGND
32	AIGND	66	ACH9
33	ACH1	67	AIGND
34	ACH8	68	ACH0

Table 5: pinout of the SCSI 68 pole male connector PCI M or B SERIES BOARD

_____

3. Hardware Connections

Usually, this universal breakout box is used in electrophysiological and pharmacological experiments. Figure 4 shows how to connect the INT-20X breakout box to the computer with the I/O boards and, optionally, a perfusion system with 8 valves.

Important: It is necessary first to install and configure the NI data acquisition board(s) and then to connect the other hardware components. Please read the NI user manual of the appropriate board information on installing and configuring the boards.
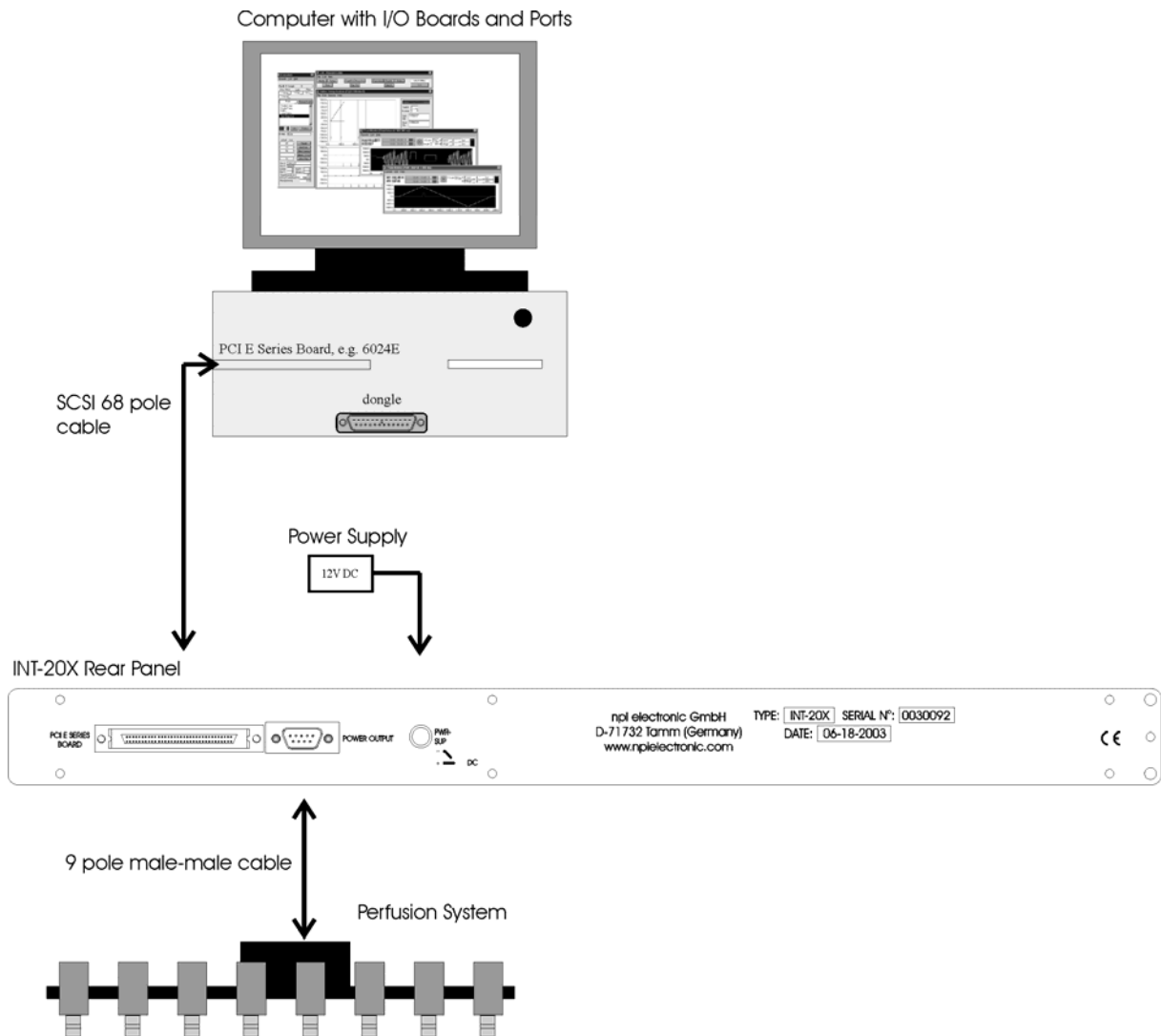
Figure 4: sample hardware connection of the INT-20X

_____

4. Technical Data

Analog Input

Number of channels	in	NRSE Mode	16
		DIFF Mode	8
Input resistance			1MΩ
Max. Input range		bipolar	±10V
		unipolar	0…10V
Input coupling			DC

Transfer characteristics depend on the board type which is used. Please read the appropriate user manual from National Instruments (shipped with the board as PDF-document).

Analog Output

Number of channels	2
Voltage range	±10V
Output coupling	DC

Transfer characteristics depend on the board type which is used. Please read the appropriate user manual from National Instruments (shipped with the board as PDF-document).

Digital I/O

Number of channels	8
Compatibility	TTL/CMOS

Power Input

External Power Input (for valve control)	12…36 V

Power Output

Maximum Voltage	Input voltage – 0.5V
Maximum Current (per channel, only one channel active)	500mA

_____

Index